

Sub D1
41. The monitoring arrangement of Claim 39 wherein the portable device includes a display arrangement configured for using the data signal for display to an operator of the portable device.

5 42. The monitoring arrangement of claim 39 wherein said boring tool includes a locating signal transmitter which transmits a locating signal for locating an underground position of the boring tool and wherein said portable device includes a locating section for receiving the locating signal for use in identifying the underground position of the boring tool.

10 43. The monitoring arrangement of claim 39 wherein said drilling system includes a drill string extending from the drill rig to the boring tool configured for receiving a push force applied by the drill rig to move the boring tool in a forward direction and wherein said monitoring arrangement includes a push force sensing arrangement which generates a push force signal for inclusion as at least a portion of said data signal.

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44. The monitoring arrangement of claim 39 wherein said operational parameter is capable of violating at least a selected one of a minimum and a maximum predetermined value and wherein said communication arrangement is configured for transferring, as part of said data signal, a warning to said portable device that the selected predetermined value has been violated.

Sub E1
45. The monitoring arrangement of claim 44 wherein said portable device is configured for providing at least a selected one of an audio indication and a visual indication in response to receipt of said warning.

Sub D2
46. The monitoring arrangement of claim 39 wherein said operational parameter is capable of violating at least a selected one of a minimum and a maximum predetermined value and wherein said portable device is configured for issuing a warning that the selected predetermined value has been violated.

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47. The monitoring arrangement of claim 39 wherein said operational parameter is a push force with which the boring tool is being pushed forward by the drill rig such that a maximum push value is established beyond which the boring tool may be damaged, said detection arrangement producing the data signal responsive to exceeding the maximum push value and wherein said portable device is configured to provide an indication of violation of the maximum push value when the maximum push value is exceeded.

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48. The monitoring arrangement of claim 39 wherein said boring tool uses drilling mud provided from said drill rig and wherein said operational parameter is a status of the drilling mud for inclusion as at least a portion of said data signal.

Sub E1
49. The monitoring arrangement of claim 39 wherein said portable device is configured to provide an operator warning based on the status of said drilling mud.

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Sub D3
50. The monitoring arrangement of claim 39 wherein said boring tool is attached to and moved by a drill string having one minimum bend radius and extending from the drill rig and a utility to be installed includes another minimum bend radius and wherein said detection arrangement at the drill rig includes a drill path monitoring arrangement for monitoring curvature of the underground bore being formed by the boring tool as said operational parameter and for

comparing at least a selected one of the minimum bend radius of the drill string and the minimum bend radius of the utility with the curvature of the underground bore to form at least a portion of said data signal.

51. The monitoring arrangement of claim 50 wherein said portable device is configured for indicating that the selected minimum bend radius is being violated.

52. The monitoring arrangement of claim 51 wherein the selected minimum bend radius is a greater one of the minimum bend radius of the drill string and the minimum bend radius of the utility and the portable device is configured to provide an indication of violation of the greater minimum bend radius.

53. In a drilling system for performing underground boring including a drill rig and a boring tool which is configured for moving through the ground under control of the drill rig to form an underground bore, a method comprising the steps of:

monitoring at least one operational parameter using a detection arrangement at said drill rig to produce a data signal relating to at least one of a utility to be installed in the underground bore, the drill rig and the boring tool; and transferring the data signal, relating to the operational parameter, to a portable device for use by the portable device.

~~54. The method of Claim 53 including the step of providing a telemetry link between the drill rig and the portable device and said transferring step includes the step of using the telemetry link for transmitting the data signal to the portable device.~~

55. The method of Claim 53 wherein the portable device includes a display arrangement and said method includes the step of using the data signal for a display presentation to an operator of the portable device.

56. The method of claim 53 wherein said boring tool includes a locating signal transmitter which transmits a locating signal for locating an underground position of the boring tool and wherein said method includes the step of configuring the portable device for receiving the locating signal for use in identifying the underground position of the boring tool.

57. The method of claim 53 wherein said drilling system includes a drill string extending from the drill rig to the boring tool configured for receiving a push force applied by the drill rig to move the boring tool in a forward direction and wherein said monitoring step includes the step of sensing the push force to generate a push force signal for inclusion as at least a portion of said data signal.

58. The method of claim 53 wherein said operational parameter is capable of violating at least a selected one of a minimum and a maximum predetermined value and wherein said transferring step includes the step of sending, as at least a portion of said data signal, a warning to said portable device that the selected predetermined value has been violated.

59. The method of claim 58 including the step of indicating receipt of said warning at the portable device using at least a selected one of an audio indication and a visual indication.

Sub D5
60. The method of claim 53 wherein said operational parameter is capable of violating at least a selected one of a minimum and a maximum predetermined value and said method further comprising the step of issuing a warning, using said portable device, that the selected predetermined value has been violated.

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61. The method of claim 53 wherein said operational parameter is a push force with which the boring tool is being pushed forward by the drill rig such that a maximum push value is established beyond which the boring tool will be damaged and wherein said monitoring step monitors the push force as said operational parameter and said transferring step sends said data signal to the portable device responsive to violation of the maximum push value when the maximum push value is exceeded.

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62. The method of claim 53 wherein said boring tool uses drilling mud provided from said drill rig and wherein said monitoring step monitors a status of the drilling mud for inclusion as at least a portion of said data signal.

Sub C8
~~63. The method of claim 53 including the step of issuing an operator warning using the portable device based on the status of said drilling mud.~~

Sub D5
64. The method of claim 53 wherein said boring tool is attached to and moved by a drill string ~~having one~~ minimum bend radius and extending from the drill rig and a utility to be installed includes another minimum bend radius and wherein said monitoring step monitors curvature of the underground bore being formed by the boring tool as said operational parameter and said method further comprises the step of comparing at least a selected one of the minimum bend radius of the drill string and the minimum bend radius of the utility with the curvature of the underground bore to form at least a portion of said data signal.

Sub E1
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65. The method of claim 64 including the step of using the portable device to indicate that the selected minimum bend radius is being violated.

66. The method of claim 64 including the steps of selecting the minimum bend radius as a greater one of the minimum bend radius of the drill string and the minimum bend radius of the utility and configuring the portable device to provide an indication of violation of the greater minimum bend radius.

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67. In a drilling system for performing underground boring including a drill rig and a boring tool which is configured for moving through the ground under control of the drill rig to form an underground bore, a monitoring arrangement comprising:

a detection arrangement for monitoring at least one operational parameter which is at least measurable at the drill rig to produce a data signal relating to at least one of a utility to be installed in the underground bore, the drill rig and the boring tool;

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a portable device configured for receiving the data signal relating to the operational parameter for use by the portable device; and

a communication arrangement for transferring the data signal from the detection arrangement to the portable device.

Sub C9
68. ~~The monitoring arrangement of Claim 67 wherein said communication arrangement includes a telemetry link between the drill rig and the portable device for transferring the data signal to the portable device.~~

Sub D7
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69. The monitoring arrangement of Claim 67 wherein the portable device includes a display arrangement configured for using the data signal for display to an operator of the portable device.

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70. The monitoring arrangement of claim 67 wherein said boring tool includes a locating signal transmitter which transmits a locating signal for locating an underground position of the boring tool and wherein said portable device includes a locating section for receiving the locating signal for use in identifying the underground position of the boring tool.

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71. The monitoring arrangement of claim 67 wherein said drilling system includes a drill string extending from the drill rig to the boring tool configured for receiving a push force applied by the drill rig to move the boring tool in a forward direction and wherein said monitoring arrangement includes a push force sensing arrangement which generates a push force signal for inclusion as at least a portion of said data signal.

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72. The monitoring arrangement of claim 67 wherein said operational parameter is capable of violating at least a selected one of a minimum and maximum predetermined value and wherein said communication arrangement is configured for transferring, as part of said data signal, a warning to said portable device that said predetermined value has been violated.

Sub E1
73. The monitoring arrangement of claim 72 wherein said portable device is configured for providing at least a selected one of an audio indication and a visual indication in response to receipt of said warning.

Sub D8
74. The monitoring arrangement of claim 67 wherein said operational parameter is capable of violating at least a selected one of a minimum and maximum predetermined value and wherein said portable device is configured for issuing a warning that the selected predetermined value has been violated.

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75. The monitoring arrangement of claim 67 wherein said operational parameter is a push force with which the boring tool is being pushed forward by the drill rig such that a maximum push value is established beyond which the boring tool may be damaged, said detection arrangement producing the data signal responsive to exceeding the maximum push value and wherein said portable device is configured to provide an indication of violation of the maximum push value when the maximum push value is exceeded.

76. The monitoring arrangement of claim 67 wherein said boring tool uses drilling mud provided from said drill rig and wherein said operational parameter is a status of the drilling mud for inclusion as at least a portion of said data signal.

Sub E1
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77. The monitoring arrangement of claim 76 wherein said portable device is configured to provide an operator warning based on the status of said drilling mud.

Sub D9

5 78. The monitoring arrangement of claim 67 wherein said boring tool is attached to and moved by a drill string having one minimum bend radius and extending from the drill rig and a utility to be installed includes another minimum bend radius and wherein said detection arrangement at the drill rig includes a drill path monitoring arrangement for monitoring curvature of the underground bore being formed by the boring tool as said operational parameter and for comparing at least a selected one of the minimum bend radius of the drill string and the minimum bend radius of the utility with the curvature of the underground bore to form at least a portion of said data signal.

B Sub E1

10 79. The monitoring arrangement of claim 78 wherein said portable device is configured for indicating that the selected minimum bend radius is being violated.

80. The monitoring arrangement of claim 79 wherein the selected minimum bend radius is a greater one of the minimum bend radius of the drill string and the minimum bend radius of the utility and the portable device is configured to provide an indication of violation of the greater minimum bend radius.

81. In a drilling system for performing underground boring including a drill rig and a boring tool which is configured for moving through the ground under control of the drill rig to form an underground bore, a method comprising the steps of:

monitoring at least one operational parameter which is at least measurable at said drill rig to produce a data signal relating to at least one of a utility to be installed in the underground bore, the drill rig and the boring tool; and transferring the data signal, relating to the operational parameter, to a portable device for use by the portable device.

Sub C12
B Sub D10

20 82. The method of Claim 81 including the step of providing a telemetry link between the drill rig and the portable device and said transferring step includes the step of using the telemetry link for transmitting the data signal to the portable device.

83. The method of Claim 81 wherein the portable device includes a display arrangement and said method includes the step of using the data signal for a display presentation to an operator of the portable device.

25 84. The method of claim 81 wherein said boring tool includes a locating signal transmitter which transmits a locating signal for locating an underground position of the boring tool and wherein said method includes the step of configuring the portable device for receiving the locating signal for use in identifying the underground position of the boring tool.

30 85. The method of claim 81 wherein said drilling system includes a drill string extending from the drill rig to the boring tool configured for receiving a push force applied by the drill rig to move the boring tool in a forward direction and wherein said monitoring step includes the step of sensing the push force to generate a push force signal for inclusion as at least a portion of said data signal.

Sub E1

86. The method of claim 81 wherein said operational parameter is capable of violating a minimum or maximum predetermined value and wherein said transferring step includes the step of sending, as at least a portion of said data signal, a warning to said portable device that said predetermined value has been violated.

Sub E1
87. The method of claim 86 including the step of indicating receipt of said warning at the portable device using at least a selected one of an audio indication and a visual indication.

Sub D1, D5
88. ~~The method of claim 81 wherein said operational parameter is capable of violating a minimum or maximum predetermined value and said method further comprising the step of issuing a warning, using said portable device, that the selected predetermined value has been violated.~~

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10 89. The method of claim 81 wherein said operational parameter is a push force with which the boring tool is being pushed forward by the drill rig such that a maximum push value is established beyond which the boring tool will be damaged and wherein said monitoring step monitors the push force as said operational parameter and said transferring step sends said data signal to the portable device responsive to violation of the maximum push value when the maximum push value is exceeded.

90. The method of claim 81 wherein said boring tool uses drilling mud provided from said drill rig and wherein said monitoring step monitors a status of the drilling mud for inclusion as at least a portion of said data signal.

Sub C1
91. ~~The method of claim 81 including the step of issuing an operator warning using the portable device based on the status of said drilling mud~~

Sub D1
20 92. The method of claim 81 wherein said boring tool is attached to and moved by a drill string having one minimum bend radius and extending from the drill rig and a utility to be installed includes another minimum bend radius and wherein said monitoring step monitors curvature of the underground bore being formed by the boring tool as said operational parameter and said method further comprises the step of comparing at least a selected one of the minimum bend radius of the drill string and the minimum bend radius of the utility with the curvature of the underground bore to form at least a portion of said data signal.

Sub E1
93. The method of claim 92 including the step of using the portable device to indicate that the selected minimum bend radius is being violated.

B1 Sub D1, D2
94. The method of claim 81 including the steps of selecting the minimum bend radius as a greater one of the minimum bend radius of the drill string and the minimum bend radius of the utility and configuring the portable device to provide an indication of violation of the greater minimum bend radius.

30 95. In a drilling system for performing an underground boring operation including a drill rig and a boring tool which is configured for moving through the ground using a drill string which extends from the drill rig to the boring tool such that the underground boring operation forms an underground bore, a monitoring arrangement comprising:

a first arrangement for transferring at least one operational parameter through the drill string from the boring tool to the drill rig, said operational parameter relating to at least one of a utility to be installed in the underground bore, the drill rig and the boring tool; and

a second arrangement, at least partially located at said drill rig, for receiving the parameter from the drill string and for transmitting the operational parameter; and